TECO
TAMPA ELECTRIC

RECEIVED
APR 10 2003
BUREAU OF AIR REGULATION

April 4, 2003

Mr. David Lloyd
Environmental Scientist
Air Enforcement Section
U.S. Environmental Protection Agency, Region IV
61 Forsyth Street, S.E.
Atlanta, Georgia 30303

Via FedEx
Airbill No. 7907 4398 3618

Re: **Tampa Electric Company Big Bend Station**
Consent Decree - Civil Action No. 99-2524 CIV-T-23F
Electrostatic Precipitator Upgrade Best Available Control Technology (BACT) Analysis

Dear Mr. Lloyd:

Tampa Electric Company (TEC) would like to take this opportunity to submit a summary of the outstanding issues and additional information regarding the electrostatic precipitator (ESP) upgrade Best Available Control Technology (BACT) Analysis for TEC's Big Bend Station. This information is submitted as a follow up to our communications via telephone. There are many significant points of concern. This submittal lists each of the major issues associated with the ESP upgrade BACT Analysis and provides a summary and discussion of each issue.

Issue 1: BACT Analysis Requirements

Summary

A BACT Analysis for upgrading each existing ESP located at the Big Bend Station is required pursuant to Condition 32.B. of the Consent Decree. The BACT Analysis is required to be conducted in conformance with applicable federal and state regulations regarding BACT analyses **except as otherwise provided in the Consent Decree**. As stated in Condition 32.B. of the Consent Decree, "Tampa Electric need not consider in this BACT Analysis the replacement of any existing ESP with a new ESP, scrubber, or baghouse, or the installation of a supplemental pollution control device of similar cost to a replacement ESP, scrubber, or baghouse."

The BACT Analysis submitted to the Environmental Protection Agency (EPA) was prepared in accordance with these Consent Decree requirements for a modified BACT analysis. Based on these requirements, TEC believes that the intent of the Consent Decree is to achieve reductions in particulate matter (PM) emissions through a BACT Analysis that focuses on reasonable upgrades and modifications to the PM control equipment (i.e., ESPs) currently in use at the Big Bend Station. TEC does not believe that the intent of this provision in the Consent Decree is to yield greenfield level PM BACT emission limitations that would require the replacement of existing PM control equipment or the installation of a supplemental control device of a similar cost to a replacement control device.

In addition to the BACT Analysis for the ESP upgrade, the Consent Decree also requires TEC to complete an optimization study that recommends Best Operational Practices (BOP) to minimize emissions from each ESP at Big Bend Station. Accordingly, TEC will expend considerable effort and funds between the BOP and BACT programs to achieve significant reductions in actual PM emission rates.

Discussion

BACT is defined by 40 Code of Federal Regulations (CFR) 52.21(b)(12) as:

> "an emissions limitation (including a visible emission standard) based on the maximum degree of reduction for each pollutant subject to regulation under the Act which would be emitted from any proposed major stationary source or major modification which the Administrator, on a case-by-case basis, taking into account energy, environmental, and economic impacts and other costs, determines is achievable for such source or modification through application of production processes or available methods, systems, and techniques, including fuel cleaning or treatment or innovative fuel combustion techniques for control of such pollutant."

The Consent Decree requires the BACT Analysis to be performed in accordance with the procedures typically performed in connection with a Prevention of Significant Deterioration (PSD) permit application. Condition 32.B. of the Consent Decree provides that the BACT Analysis is not required to consider the replacement of any existing ESP with a new ESP, scrubber, or baghouse or the installation of a supplemental control device of a similar cost to a replacement control device.

BACT Analysis procedures typically performed for a PSD permit application consist of a "top-down" assessment using the following methodology:

STEP 1 – Identify available control technologies.
STEP 2 – Eliminate the technically infeasible or unavailable technology options.
STEP 3 – Rank remaining control technologies by control effectiveness
STEP 4 – Evaluate the most effective controls and document results. If the top option is not selected as BACT, evaluate next most effective control option.
STEP 5 – Determine the emission limitation corresponding to the control technology that is the most stringent control option not otherwise rejected based on energy, environmental, and economic impacts as representing BACT.

The BACT Analysis submitted to the EPA was prepared in accordance with this "top-down" methodology as modified by the terms of the Consent Decree. Specifically, the BACT Analysis did not consider replacement of any existing ESP with a new ESP, scrubber, or baghouse, or the installation of a supplemental pollution control device of similar cost to a replacement ESP, scrubber, or baghouse.

Issue 2: BACT Analysis – ESP Upgrade Options and Cost Effectiveness

Summary

TEC contracted both Electric Power Research Institute (EPRI) and Southern Research Institute (SRI) to perform extensive testing, modeling, and to identify available upgrade options, their expected cost and benefits based upon industry accepted models and techniques for each ESP at Big Bend Station. These particular consultants were selected based upon national recognition of their expertise and knowledge of

ESP control technology. In their study and modeling, EPRI/SRI identified the following ESP upgrade options:

- Option 1 - Replacement of current analog ESP controls with of state-of-the-art digital ESP controls, evaluation and adjustment of ESP external exhaust flow rates and temperatures to design conditions, use of dedicated digital control units (DCUs), replacement of flyash gate valves with new valves designed to minimize PM re-entrainment, and upgrading the flyash removal system controls.
- Option 2 - Installation of one additional ESP field in one ESP and Option 1.
- Option 3 - Installation of two additional ESP fields (one per ESP) and Option 1.
- Option 4 - Installation of a compact hybrid particulate collector (COHPAC) and Option 1.

Option 4 was eliminated as a control option. This control technology will achieve comparable emission reductions as Option 3 with a higher cost. COHPAC is discussed in greater detail in Issue 6 below.

Step 5 of the "top-down" BACT Analysis submitted to the EPA evaluated the available ESP upgrade control options for energy, environmental, and economic impacts. Since energy and collateral environmental impacts are minor for Options 1 through 3, the Step 5 evaluation focused primarily on economic impacts. The economic analysis was conducted using site-specific ESP upgrade cost estimates provided by a control system vendor, baseline PM emission rates for Big Bend Units 1 through 3 that reflect expected ESP performance following BOP implementation using the EPA/SRI ESP model, and EPA recommended procedures for performing BACT economic analyses.

For Big Bend Station Units 1 through 3, the average and incremental cost effectiveness for Options 2 and 3 range from $10,432 to $23,710 per ton of PM controlled. Although there are no "bright lines" for acceptable BACT costs, these cost effectiveness values are well above levels typically considered economically reasonable in prior regulatory BACT determinations and clearly are <u>not</u> cost effective. For example, PM BACT controls required for a new greenfield coal-fired plant in Wyoming resulted in an average cost effectiveness of only $238 per ton of PM removed. Accordingly, Options 2 and 3 were eliminated based on adverse economic impacts and Option 1 control technology was determined to represent BACT for Units 1 through 3 at Big Bend Station. Proposed PM BACT emission limits for Units 1 through 4 are discussed in Issue 3 below.

<u>Discussion</u>

The evaluation of cost effectiveness for each feasible ESP upgrade option (Options 1, 2, and 3) was performed in accordance with EPA recommended procedures. Specifically, the economic analysis procedures recommended by the EPA's *Air Pollution Control Cost Manual* were followed. Details of the economic analysis are provided in Tables 5-2, 5-3, and 5-4 of the October 2002 BACT Analysis for Units 1 through 3, respectively. Since the "top" (i.e., most stringent) PM BACT emission limit is proposed for Big Bend Station Unit 4, analyses of energy, environmental, and economic impacts were not required for Unit 4.

The initial September 2001 BACT cost effectiveness analysis was updated in October 2002. The revision incorporates site-specific vendor control system cost estimates, excludes costs associated with the BOP, and includes PM removal due to the flue gas desulfurization (FGD) control systems in determining baseline and controlled emission rates for each control option. The revised BACT Analysis includes baseline PM emission rates for Big Bend Units 1 through 3 that have been amended to reflect expected ESP performance <u>following</u> BOP implementation using the EPA/SRI ESP model. These baseline levels will allow for an appropriate determination of the cost effectiveness of ESP upgrade control technologies for Big Bend Units 1 through 3 as they apply specifically to the BACT options. The initial September 2001 BACT Analysis included PM baseline emission rates prior to BOP implementation.

Average and incremental cost effectiveness for Options 2 and 3 range from $10,432 to $13,486 per ton of PM controlled (for Unit 1), from $10,745 to $16,008 per ton of PM controlled (for Unit 2), and from $11,678 to $23,710 per ton of PM controlled (for Unit 3). All of these cost effectiveness values are well above the levels that have been considered economically reasonable in prior regulatory agency BACT determinations.

Issue 3: Proposed PM BACT Emission Limits

Summary

TEC has proposed BACT emission limits that are consistent with the regulatory requirements described above in Issues 1 and 2. As previously stated, TEC believes the intent of the BACT Analysis required by the Consent Decree is to achieve reductions in PM emissions through reasonable upgrades and modifications to the ESP PM control equipment currently in use at the Big Bend Station. TEC strongly believes that the intent of this provision of the Consent Decree is not to yield greenfield level BACT emission limitations but rather emission limits that reflect the implementation of reasonable ESP upgrades and modifications.

A comparison of the proposed BACT PM emission limits, current permitted limits, and New Source Performance Standard (NSPS) Subpart Da limits is provided in Table 1 below.

Table 1			
Units	Proposed Limits (lb/mmbtu)	Current Permit Limits (lb/mmbtu)	NSPS Limits (lb/mmbtu)
1	0.03	0.1/0.3	0.03
2	0.03	0.1/0.3	0.03
3	0.03	0.1/0.3	0.03
4	0.01	0.03	0.03

As indicated, TEC is proposing BACT PM emission limits for Units 1 through 3 that are well below current permit limits (i.e., 0.1 and 0.3 lb/mmbtu for non-soot blowing and soot blowing operations, respectively) and that are equivalent to the NSPS Subpart Da limits. The existing ESPs for Unit 4 are significantly over-designed; i.e., achieve PM emissions rates well below the applicable NSPS limit. Accordingly, for Unit 4 TEC is proposing a BACT PM emission limit that is also well below the current permit limit and that represents the "top" or most stringent BACT PM emission limit for recently permitted greenfield coal-fired power plants.

Discussion

The proposed PM BACT emission limits were developed in accordance with the Consent Decree requirements and reflect the implementation of ESP upgrades that will achieve emission rates well below current permit limits. It is therefore inappropriate to impose BACT emission limits applicable to newly constructed coal fired units to the existing units at Big Bend Station since such limits would require ESP replacement or installation of new control equipment (e.g., baghouses). Replacement ESPs or new baghouses are specifically excluded from consideration by the Consent Decree. As such, a BACT emissions limit of 0.01 lb/mmbtu, representative of recent BACT PM determinations for new, greenfield coal-fired power plants, is not considered appropriate for existing Big Bend Station Units 1 through 3.

Issue 4: BOP and BACT Efforts

Summary

The proposed BACT PM emission limits shown above reflect the performance of Units 1 through 4 following implementation of both the BOP and ESP upgrade BACT. TEC is undertaking considerable expense and effort to reduce actual PM emissions at the Big Bend Station as a result of the implementation of both of these programs.

Discussion

Due to the fact that TEC was required to perform both a BOP and a BACT study, TEC sought to develop a comprehensive approach to reduce PM emissions. Accordingly, a major element of the BACT study includes the synergies derived from the coordinated implementation of both programs. As illustrated in the request for additional information letter dated October 9, 2002, TEC will expend considerable effort and funds between these two programs to achieve significant PM emission reductions.

Due to planned unit outages and Consent Decree deadlines, TEC has already taken steps to implement some of the planned changes. Items such as slag tank vent relocations and wide plate spacing activities can only be performed during outages of sufficient duration and will be performed during those times. Reductions in PM are already apparent in that actual PM levels have been greatly reduced since we have made various modifications and began partial BOP implementation.

Issue 5: Performance of Existing PM Control Systems

Summary

Pursuant to Conditions 32.E. and 32.F. of the Consent Decree, a PM continuous emissions monitoring system (PM CEMS) has been installed in the outlet of the common FGD scrubber serving Units 3 and 4 for evaluation purposes. The evaluation of the PM CEMS includes the development of a correlation between PM CEMS and EPA Reference Method PM emissions data using proposed Performance Specification 11, *Procedures for Particulate Matter Continuous Emissions Monitoring Systems at Stationary Sources*.

PM emissions data obtained as part of the PM CEMS evaluation are not considered suitable for setting PM BACT limits for Units 1 through 3 for a variety of reasons including: (1) the brief ("snapshot") period of data collection, (2) normal variability in control system performance, (3) differences in control systems between Units 1/2 and Units 3/4, (4) effects of required future control systems such as selective catalytic reduction (SCR) on PM emissions, and (5) effects of burning other authorized solid fuels on PM emissions. TEC has proposed PM BACT limits of 0.03 lb/mmbtu for Units 1, 2, and 3 and 0.01 lb/mmbtu for Unit 4. While actual PM emission rates may be lower during certain circumstances (e.g., combusting certain types of solid fuels, just after control system major maintenance, etc.), the PM BACT limits established for the Big Bend Station must be achievable under all authorized operating conditions.

Discussion

Further technical discussion of the various issues regarding the PM CEMS certification test data are provided as follows:

Units 1/2 and 3/4 Control Systems - Big Bend Station Units 1/2 and Units 3/4 are each equipped with ESPs and two, wet scrubber FGD systems. However, the size of the existing ESPs and the FGD design differ for Units 1/2 and Units 3/4. The ESP for Unit 4 was conservatively designed to meet the NSPS Subpart Da PM limit of 0.03 lb/mmbtu with a considerable margin of safety. For that reason, the PM loading to the common FGD scrubber for Unit 3/4 in units of lb/mmbtu will be lower for Unit 4 than for Units 1 through 3 due to the higher ESP collection efficiency for Unit 4. Products of combustion differ between Unit 4 and Units 1 through 3, primarily unburned carbon levels, which have a direct impact upon collection efficiency. Unburned carbon on Unit 4 is almost always lower than Units 1 through 3. The FGD scrubber designs also differ significantly between Units 1/2 and Units 3/4. Therefore, the PM emission rates measured during the PM CEMS certification testing (i.e., Unit 3/4 FGD scrubber outlet PM emissions) reflect the performance of the high efficiency Unit 4 ESP and as a result would not be applicable for Units 1 through 3. As noted above, TEC has proposed a PM BACT limit of 0.01 lb/mmbtu for Unit 4.

Variability of ESP Performance – The ESPs were optimized prior to conducting the PM CEMS certification tests. It is neither practical nor reasonable to expect the ESPs to operate at optimal performance continuously. As with all major equipment, periodic maintenance is necessary to maintain satisfactory ESP performance. Emission rates will fluctuate somewhat between major maintenance periods – the BOP has been developed to minimize PM emissions during normal ESP operation and establishes appropriate maintenance activities and schedules. In addition, the brief period of PM CEMS certification testing would not have captured all routine ESP operating conditions, some of which could lead to elevated PM emissions.

Variability of FGD System Performance – Similar to ESPs, the PM removal efficiency of the FGD systems would be expected to vary over time and between maintenance periods. Accordingly, the PM emission rates achieved during the brief PM CEMS certification testing is not an accurate prediction of the FGD system performance.

Analysis of PM CEMS Certification Test Data – A summary of the PM CEMS certification test data is provided in Attachment A to this letter. The test data shows considerable variability from run to run. Also, these test data show a snapshot in time, where in fact, TEC is required to achieve a PM emission rate under all approved operating circumstances. In reviewing the June 2002 and January 2003 PM CEMS certification testing, most of the data points were taken when Unit 3 and 4 were operating below the maximum permitted capacity of which could lead to lower PM emission rates that are not representative of all approved operating conditions. In many instances, the test data shows PM emissions greater than 0.01 lb/mmbtu and are as high as 0.0204 lb/mmbtu. Accordingly, the PM CEMS certification test data is considered reasonably consistent with the proposed PM BACT emission limits and does not justify a 0.01 lb/mmbtu PM BACT emission limit for Units 1 through 3.

Effect of Future NO_x Control Systems – The NO_x reduction requirements of the Consent Decree result in TEC employing low NO_x burners, reduced excess air, staged combustion, and over fire air technologies at Big Bend Station. It is well understood that these NO_x control technologies increase the unburned carbon content of the fly ash resulting in somewhat higher PM emissions. Most of these technologies are not yet incorporated and as such are not reflected in the PM CEMS certification test results. Low NO_x burner technology and optimization is planned for all four units at Big Bend Station.

Effects of Future SO_3 Reduction Control Systems – The use of selective catalytic reduction control technology for NO_x compliance as stated in the EPA Consent Decree will result in increased formation of SO_3. If TEC is required to address this issue through the use of SO_3 reduction technology, increases in PM emissions may result. SO_3 reduction controls will raise the ash resistivity slightly. This increase in resistivity, in turn, will make the ash harder to collect resulting in a slight increase in PM emissions. SO_3 reduction technology is not yet employed at the Big Bend Station and therefore not reflected in the PM CEMS certification test data.

Variability of Solid Fuel Ash Content and Chemistry – TEC routinely uses fuels and fuel blends which result in fly ash that is more difficult to collect than the solid fuel used during the PM CEMS certification testing. This could result in a slightly higher PM emission than that experienced during the PM CEM certification testing. As noted above, the PM BACT limits established for the Big Bend Station must be achievable under all authorized operating conditions, including the use of all authorized fuels, future NO_x control systems, future SO_3 reduction control systems, variability of ESP performance and variability of FGD performance.

Sargent & Lundy Study – Sargent & Lundy, LLC (S&L) was contracted by TEC to determine the PM removal efficiency of wet FGD control systems. S&L concluded, based on their research, that a mathematical algorithm to estimate FGD PM removal efficiencies using FGD inlet PM loading rates and key FGD design parameters (e.g., gas velocity, liquid-to-gas ratio, etc.) does not presently exist. S&L's review of available PM test data for existing wet FGD systems indicates that, in general, FGD PM removal efficiency increases with increasing inlet PM concentration (i.e., PM grain loading) and increasing particle size. Conversely, FGD PM removal efficiency will decrease as the PM inlet concentration decreases and the inlet PM particle size becomes smaller.

S&L identified one existing wet FGD system, located at the Owensboro Municipal Utility (OMU) Elmer Smith Station, that is considered reasonably comparable to the FGD system serving Big Bend Units 1 and 2 and reviewed PM test data taken there. In addition, S&L obtained predicted PM removal efficiencies for FGD systems from three FGD system suppliers based upon TEC PM emission rates and FGD system operating conditions. S&L concluded that TEC's prior estimates of FGD PM removal efficiencies for the Big Bend Station are generally consistent with the available data.

Overall the S&L study concluded that the PM removal efficiency of the Big Bend FGD scrubbers will decrease as the FGD inlet PM loading rate (ESP outlet PM rate) is lowered and vice versa. Accordingly, reducing the ESP outlet PM loading rate by installing additional (and costly) fields to the existing ESPs would not be expected to significantly reduce actual PM emissions to the atmosphere since the improvement in ESP PM removal will be offset by a reduction in FGD PM removal efficiency. The S&L study is provided in Attachment B to this letter.

Issue 6: COHPAC Feasibility

Summary

Compact Hybrid Particulate Collector (COHPAC) technology is considered both technically infeasible and economically unreasonable. COPHAC is considered technically infeasible due to the fact that high sulfur fuels are burned at the Big Bend Station. Combustion of high sulfur fuels typically result in excessively high fabric filter bag failure rates due to the corrosive nature of the exhaust gases. These bag failures, in turn, can result in PM emissions rates higher than other alternatives.

COHPAC technology is also considered economically unreasonable since this technology (assuming it is technically feasible) would achieve comparable PM emission reductions as the installation of additional ESP fields at a significantly higher cost. Estimated total cost of COHPAC technology is approximately $25.6 million in 2003 dollars per Big Bend Station unit based on EPRI guidelines for ESP upgrades. This cost estimate assumes a consumer price index (CPI) inflation adjustment of approximately three percent using a formula of (2 x $9,790,000/per ESP in 1999 dollars x CPI^3) along with an approximate cost increase of twenty percent due to site constraints. In contrast, two additional ESP fields per ESP unit (Option 3) have an estimated equipment cost of approximately $5 million and a total installed cost of $15 to $17 million per unit at Big Bend Station. Therefore, the application of COPHAC is not deemed an economically reasonable technology since additional fields will achieve comparable or greater emission reductions for less cost.

Discussion

COHPAC involves the installation of a pulse-jet fabric filter downstream of an existing ESP. COHPAC is installed in series with an existing ESP and serves as a polishing device to further reduce PM emissions. COHPAC fabric filters are typically designed with an air-to-cloth ratio of 8:1 feet per minute (ft/min) or roughly twice the design air-to-cloth ratio of 4:1 ft/min for a fabric filter used as the primary PM collection system. Accordingly, a COHPAC fabric filter is typically 50-percent of the size of a utility boiler fabric filter system that serves as the main PM collection system.

Because Option 3 will achieve comparable control reductions at significantly lower cost, application of COPHAC is considered an inferior control technology in the context of a BACT cost effectiveness analysis since alternative control technologies (e.g., additional ESP fields) will achieve comparable or greater emission reductions for less cost. Consistent with guidance contained in EPA's October 1990 Draft *New Source Review Workshop Manual* (reference Section IV.SD.2.b., Page B.43), cost effectiveness evaluations of inferior control technologies are not required.

Issue 7: ESP Specific Collecting Area (SCA)

Summary

It has been suggested that the specific collecting area (SCA) of the existing ESPs for Units 1 through 3 be increased to be equal to that of Unit 4. In contrast to Units 1 through 3, Unit 4 is subject to NSPS Subpart Da and was designed to meet the applicable NSPS limit with a considerable margin of safety. Increasing the SCA of the existing ESPs for Units 1 through 3 to that of Unit 4 is considered to be physically infeasible and inconsistent with the terms of the Consent Decree. An evaluation of the existing Units 1 through 3 ESPs shows that approximately twice the number of existing fields would be needed to achieve SCAs comparable to Unit 4.

Discussion

Big Bend Station's Unit 4 has a SCA of 565 ft^2 per 1,000 acfm. As noted above, approximately twice the number of existing fields would be needed to achieve a SCA comparable to Unit 4. For example, Unit 1 existing ESPs have a total SCA of 280 ft^2 per 1,000 acfm. To increase the SCA of these ESPs to that of Unit 4, five fields would need to be added to the existing four field Unit 1 old ESP and six fields added to the existing Unit 1 seven field new ESP. Accordingly, increasing the SCA of Units 1 through 3 ESPs to be comparable to Unit 4 would necessitate replacing the existing ESPs with new ESPs. The EPA Consent Decree specifically states that the PM BACT Analysis need not consider the replacement of any existing ESP with a new ESP.

The cost effectiveness of approximately $11,000 per ton of PM removed for adding one additional field to one existing ESP for each unit (Option 2) is well above the costs considered reasonable for other PM BACT Analysis. The costs of adding one additional field to both existing ESPs for each unit (Option 3) are also well above the costs considered reasonable for other PM BACT analyses. Accordingly, TEC considers the proposed PM BACT limit of 0.03 lb/mmbtu for Units 1 through 3 to represent ESP upgrade for the PM BACT in accordance with the provisions of the EPA Consent Decree.

Conclusions

As previously stated, TEC does not believe that the objective of provision 32.B in the Consent Decree is to submit a greenfield level PM BACT emission limitation. This provision does not require TEC to replace existing PM control equipment or to install supplemental control devices of a similar cost to a replacement control device at Big Bend Station. TEC has undertaken compliance with the Consent Decree requirements very seriously. We have spent considerable time, effort and cost to come up with improvements in both operations and the ESP installations, ash handling systems and controls to meet the agreed upon requirements. In good faith, TEC has already implemented many of the recommended items and has already shown significant reductions in PM emissions. We strongly believe that we have acted responsibly and provided a credible analysis of our units and demonstrated this to EPA. The end result of this analysis is that the PM BACT for Big Bend Station Units 1 through 3 is 0.03 lb/mmbtu. This result is based upon the intent and requirements of the Consent Decree along with the foregoing discussion of the key issues.

TEC appreciates the opportunity to provide this summary and discussion of additional information to the EPA. We look forward to working with you to ensure that a reasonable ESP upgrade BACT determination is made for the Big Bend Station. TEC is confident that this determination will benefit the environment while encouraging the development of future PM reduction technologies.

If you have any questions, please feel free to telephone Shelly Castro or me at (813) 641-5033.

Sincerely,

for Laura R. Crouch
Manager
Environmental Affairs

EA/gm/SSC156

Enclosures

c/enc B. Gelber, USDOJ
B. Buckheit, USEPA
T. Hankinson, USEPA
J. Campbell, EPCHC
G. D'Angelo, FDEP
J. Kissel, FDEP SW
A. Linero, FDEP
W. Schmidt, US Attorney
S. Woodard, EPCHC

ATTACHMENT A

TAMPA ELECTRIC COMPANY
BIG BEND STATION

PM CEMS Certification Test Data

UNIT 3 - 4 POST FGD PM EMISSION RATES
*WEEK OF JUNE 17, 2002

DATE	START	STOP	LOAD (MW)	RUN	TRAIN A (LB/MMBTU)	TRAIN B (LB/MMBTU)
6/17/2002	17:05	18:43	438	1	0.0106	0.0141
6/18/2002	8:06	10:04	440	2	0.0071	0.0080
6/18/2002	11:12	12:50	460	3	0.0077	0.0075
6/18/2002	13:37	15:16	460	4	0.0116	0.0102
6/18/2002	16:23	18:01	460	5	0.0092	0.0113
6/19/2002	8:05	9:43	410	6	0.0090	0.0166
6/19/2002	10:31	12:09	453	7	0.0070	0.0166
6/19/2002	12:56	14:34	450	8	0.0121	0.0120
6/19/2002	15:42	17:19	452	9	0.0040	0.0152
6/20/2002	10:10	11:28	710	10	0.0076	0.0173
6/20/2002	12:14	13:52	825	11	0.0077	0.0085
6/20/2002	14:40	16:17	798	12	0.0047	0.0172
6/20/2002	17:04	18:43	707	13	0.0077	0.0137
6/21/2002	8:26	10:04	897	14	0.0065	0.0066
6/21/2002	10:52	12:29	870	15	0.0078	0.0051
6/21/2002	13:18	14:54	847	16	0.0115	0.0090
6/21/2002	15:42	17:19	890	17	0.0117	0.0157
6/22/2002	8:06	10:04	773	18	0.0043	0.0204
6/22/2002	10:51	12:30	847	19	0.0061	0.0103
6/22/2002	13:16	14:49	850	20	0.0067	0.0121
6/22/2002	16:02	17:44	885	21	0.0067	0.0058
6/24/2002	8:06	9:44	825	22	0.0076	0.0060
6/24/2002	10:52	12:29	879	23	0.0033	0.0037
6/24/2002	13:37	15:15	860	24	0.0047	0.0040
6/24/2002	15:24	15:29	-	25	-	-
6/24/2002	18:27	20:07	440	26	0.0070	0.0110

**NOTE: THIS GROUP OF TESTING WAS PERFORMED WITH REFERENCE METHOD 5.*

UNIT 3 - 4 POST FGD PM EMISSION RATES
*WEEK OF JANUARY 13, 2003

DATE	START	STOP	LOAD (MW)	RUN	TRAIN A (LB/MMBTU)	TRAIN B (LB/MMBTU)
1/13/2003	22:30	22:38	-	1	-	Void
1/13/2003	23:17	1:39	225	2	0.0098	Void
1/15/2003	16:01	17:28	700	3	0.0054	0.0026
1/15/2003	18:42	20:14	750	4	0.0031	0.0022
1/15/2003	21:05	22:34	750	5	0.0044	0.0039
1/15/2003	23:51	1:45	740	6	0.0032	0.0045
1/16/2003	2:51	4:37	770	7	0.0028	0.0058
1/16/2003	5:41	7:09	800	8	Void	0.0015
1/16/2003	8:27	9:58	690	9	0.0083	0.0031
1/16/2003	10:31	11:56	650	10	0.0069	0.0059
1/16/2003	12:40	14:01	640	11	0.0049	0.0041
1/16/2003	14:32	15:57	640	12	0.0042	0.0068
1/16/2003	16:33	17:55	600	13	0.0041	0.0025
1/16/2003	18:42	20:05	640	14	0.0043	0.0028
1/16/2003	20:46	22:11	650	15	0.0136	0.0016
1/16/2003	22:35	23:57	650	16	0.003	0.0051
1/17/2003	0:44	2:04	650	17	0.0057	0.0039
1/17/2003	2:48	4:13	590	18	0.0038	0.0032
1/17/2003	4:57	6:30	600	19	0.0029	0.005
1/17/2003	7:22	8:44	706	20	0.0042	0.0045
1/17/2003	9:26	10:52	704	21	0.0041	0.0032

****NOTE: THIS GROUP OF TESTING WAS PERFORMED WITH REFERENCE METHOD 5B.***

ATTACHMENT B

TAMPA ELECTRIC COMPANY
BIG BEND STATION

Sargent and Lundy FGD PM Removal Study

Tampa Electric Company

Quantification of Fly Ash Particulate Removal By Wet FGD Systems SL-008005 Report April 2003

Sargent & Lundy LLC

Sargent & Lundy LLC
55 E. Monroe Street
Chicago, IL 60603

This report was prepared and reviewed as follows:

David G. Sloat
Prepared by

William DePriest
Reviewed by

William DePriest
Approved by

1 INTRODUCTION

Tampa Electric Company (TECo) has requested that Sargent & Lundy LLC (S&L) determine the amounts of fly ash particulate removed when flue gas passes through a wet FGD (flue gas desulfurization) system. TECo is especially interested in identifying the amount of particulate removal when the inlet particulate loading to a wet FGD is 0.03 lb/MBtu or less. Furthermore, the characteristics of the fly ash are based upon conventional combustion techniques and do not consider any types of collection interactions that may occur in the FGD when post combustion processes are introduced.

TECo has two independent wet FGD systems installed at the Big Bend Station. The first was installed in 1985 to serve Big Bend Unit 4. The FGD system was subsequently modified to increase capacity and in June of 1995, Unit 3 flue gas was integrated into its gas path. The FGD system now treats the entire flue gas streams of both Units 3&4. The FGD was designed and supplied by Research Cottrell and is a 1978 vintage FGD system. The modified system has an L/G of approximately 70 and a superficial gas velocity of almost 12 feet per second. The system is a double loop wet limestone process with forced oxidation and produces commercial grade gypsum as a by-product. The system consists of four absorber modules working in parallel. The "counter current" absorber has several spray levels in a quencher section followed by two spray levels and a single dual flow tray in the absorber section that produce slurry droplets that fall by gravity in the absorber as the flue gas flow upward against the droplets. The second FGD system was installed in January 2000 and was designed and supplied by Wheelabrator Air Pollution Control. This second system contains a single absorber module that treats the entire flue gas flow of both Units 1&2. The absorber is a single loop counter current design with four spray levels above a single dual flow tray. This second FGD system also is a forced oxidation process that produces commercial grade gypsum. The two systems differ considerably in L/G, number and type of spray levels, gas velocity and ductwork configuration. All of which have an impact on the FGD systems particulate collection characteristics. The design basis of the Unit 1-2 FGD system was used primarily in this analysis because of its more modern design.

Just as the two absorbers at Big Bend have differences, so are there differences between the Big Bend FGD systems and most of the other FGD systems that are operating on utility power plants. The term wet FGD is a generic term not meant to imply that they all systems exhibit the same absorption and particulate removal qualities. The family of wet FGD systems that is very similar to Big Bend's FGD is small. In spite of this fact, TECo wanted to obtain as much information as possible about the particulate removal capabilities of wet FGD systems and decide if the information could be applicable to the Big Bend FGD systems.

A mathematical determination of the particulate removal efficiency of a wet FGD would require not only the development of correlation between FGD design and particulate characteristics, but also field testing to substantiate any developed equation. If a correlation does exist, it is S&L's judgement that the correlation would need to include, but not necessarily be limited to the following parameters-- inlet particulate loading, particle size, and wet FGD operating parameters such as gas velocity, L/G ratio, type of mass transfer media, number of trays, number of spray levels and other possibly parameters. Without these specific features, the accuracy and precision of a correlation would be suspect. In our experience and to our knowledge, such a mathematical correlation does not exist in commonly used engineering texts or is available in the public domain..

Since a correlation for particulate removal in a wet FGD system cannot be found, S&L implemented an approach consisting of the following steps:

1. A search of published papers was completed to identify what data, and the analytical data collection methods used with regard to the particulate removal from wet FGD systems.
2. A search of existing databases was completed to identify if there was sufficient data that would allow S&L to develop a mathematical correlation of particulate removal efficiency of wet FGD systems.
3. To get an independent assessment of the removal efficiency, several FGD vendors with USA experience were contacted. They were asked to provide their experience with particulate matter removal of full scale and pilot wet FGD systems.
4. The last step was to compare these findings to TECo's findings.

The results of the above steps are discussed in more detail in the following sections.

2 LITERATURE SEARCH

In the first part of the project a search of existing publications was performed both with on-line resources as well as through information in Sargent & Lundy's files. Databases searched included ABI_INFORM, COMPENDEX, US Department of Energy's Energy Citations Database, and Google.

Papers identified include:

- **Multi-Pollutant Control with the Chiyoda CT-121 FGD,** Norio Miyata, Sosuke Kido, et al, Megasymposium, August 20-23, 2001
- **Henderson Municipal Power & Light – A Low Cost Phase I Clean Air Act Retrofit,** Benson, Garner, Murphy, et al, Supplied by Wheelabrator Air Pollution Control
- **Results of High Velocity Single Absorber Operation at OMU's Elmer Smith Station,** Frizzell, Kevin, et al, 1997 EPRI/EPA Megasymposium Washington, D.C. U.S.A
- **Results of Particulate and Gaseous Sampling from a wet Scrubber Pilot Plant,** Johnson, Bhat, and Cushing, 10th Particulate Control Symposium, April 1993

A summary of the above papers is given below.

Multi-Pollutant Control with the Chiyoda CT-121 FGD

In the CT-121 process, the flue gas is sparged into a vessel filled with limestone slurry using a jet bubble reactor (JBR), which is different from the Big Bend FGD systems. The flue gas is bubbled through the limestone slurry then is gathered and entrained droplets are removed as the gas passes through a mist eliminator. The JBR incorporates all of the necessary steps for SO_2 absorption, oxidation, neutralization, crystallization, and some dust removal in a single reactor module. Most other wet FGD systems in the USA, are "counter current" flow (e.g. TECo's Big Bend two wet FGD systems) where slurry droplets are sprayed into the flue gas. However, with the CT-121 JBR the gas is actually sparged into a tank of slurry and small bubbles are formed as the gas escapes to the top surface of the tank. The velocity of the gas leaving the sparger is believed to carry particulate matter into a solid wall of liquid until a bubble is formed.

Testing of the CT-121 JBR was performed over a large range of inlet conditions. The inlet conditions ranged from a precipitator fully de-energized (fly ash inlet loading of 4.9 to 5.8 lb/MBtu), to a partially energized (inlet loading of 0.17 to 0.82 lb/MBtu), to a fully energized condition (inlet loading of 0.02 to 0.12 lb/MBtu). The efficiency, unfortunately, was not correlated to a varying range of particulate loading, size distribution, or FGD parameters. An outlet particulate loading range was reported for all of the tests, as well as average removal efficiency at each precipitator condition. The "Fully Energized" condition is most representative of the inlet ash loading Big Bend Station, and under these conditions, the Chiyoda FGD was performing at 85% particulate removal. A summary of the results is shown in Table 1 below:

Table 1, Chiyoda 121 JBR Particulate Collection

ESP Operating Condition	Particulate Range, lb/Mbtu		Average Removal Efficiency in Chiyoda Absorber
	Inlet	Outlet	
Fully Energized	0.02 to 0.12	0.006 to 0.011	85.0%
Partially Energized	0.17 to 0.82	0.010 to 0.017	95.8%
Fully De-energized	4.9 to 5.8	0.042 to 0.056	99.1%

From the Chiyoda 121 paper, we concluded that the mass transfer and particulate collection mechanisms are significantly different in the JBR compared to the counter current absorbers used at Big Bend. Therefore, the particulate removal results from the CT-121 are not considered to be representative, similar or comparable to the expectations of the Big Bend wet FGD systems. However, the concept that removal efficiency is greatest under conditions of high grain loading and particle size has been demonstrated. In general terms, this phenomenon should exist with most wet FGD systems.

Henderson Municipal Power & Light – A Low Cost Phase I Clean Air Act Retrofit

The Henderson wet FGD system was designed and supplied by Wheelabrator Air Pollution Control and installed in 1995. The system is a thiosorbic lime based system that produces a dewatered waste for landfill. The absorber is similar to Big Bend's Unit 1 & 2 absorber in that it has a dual flow tray (a perforated plate), however, the absorber only has one spray level and an L/G of 30 gal/1000acfm compared to Big Bend Unit 1 & 2's L/G of 80 gal/1000acfm.

The paper by Benson, Garner, et al, on the scrubber at Henderson Municipal Power & Light reported on the results of the scrubber performance testing. This paper reported that the dual-flow-tray scrubbers had a guaranteed particulate removal of 50% with a design inlet particulate loading of 0.21 lb/MBtu. However, tests of the FGD showed actual particulate removal of 86% for Unit 1 and 72% for Unit 2. It should be noted that these high removal rates are with a very high inlet particulate loading, close to the 0.21 lb/MBtu design value.

From this paper on the Henderson FGD, we can see that this FGD system has some similar features (tray and spray levels) to the Big Bend FGD, but the lower L/G is significantly different from Big Bend's designs and the inlet particulate loading is much higher than Big Bend's. While this spray tower FGD could perform at 72% to 86% particulate removal efficiency at high inlet loading, this inlet loading was not at all similar to Big Bend's situation of low inlet particulate loading. It is well known that wet FGD system particulate removal efficiency is highly dependent on the inlet particulate loading. Therefore, higher particulate removal efficiency is expected for the Henderson FGD than for the Big Bend FGDs, because of the much higher inlet loading. Also, there was no data presented in the paper at low inlet loading that made the paper useful for developing a correlation for Big Bend's FGD systems.

Results of High Velocity Single Absorber Operation at OMU's Elmer Smith Station

The single absorber tower design at OMU is very similar to the Big Bend Unit 1 & 2 design. The amount of slurry recycled at OMU was about 100 gal/1000acfm versus a value of 80 at Big Bend. The velocity of gas through the absorber was 13 to 15 fps compared to a value of 14 for Big Bend. The OMU absorber has five spray levels but no tray compared to 4 levels and a tray in the Big Bend Unit 1 & 2 absorber.

The results of the high velocity single absorber operational testing at OMU does relate particulate removal efficiency to inlet loading. The data shows a range of 36% to 55% particulate removals at an inlet particulate loading ranging between 0.05 to 0.09 lb/MBtu. The results at an inlet particulate loading of less than 0.05 lb/MBtu indicate that there is significantly less particulate removal taking place in the FGD. In fact, some results show increases in particulate from inlet to outlet. Relevant results from the paper are presented in Table 2 below:

Table 2, OMU Particulate Removal Results

	Location: Absorber Inlet A	Location: Wet Stack	
Test No.	Inlet Rate lb/MBtu	Outlet Rate lb/MBtu	Removal Efficiency %
1	0.0901	0.0405	55.05
2	0.0676	0.0375	44.53
3	0.0481	0.0471	2.08
4	0.0434	0.0463	(increase of 6%)
5	0.0572	0.0366	36.0
6	0.0406	0.0489	(increase of 20%)

From these tests at OMU, we can conclude that as inlet fly ash loading to the FGD decreases, so does the particulate removal capability of the FGD system. When inlet loading is below 0.05 lb/MBtu to the FGD, the OMU data does not show any net collection of particulate matter. Therefore, at the inlet loading less that 0.03 lb/MBtu, which Big Bend is expected to be at, an absorber operating similar to the way the OMU absorber was operating during the test period would not be expected to have any significant net particulate removal.

Results of Particulate and Gaseous Sampling from a Wet Scrubber Pilot Plant

The final source of information from the literature is from a paper authored by Johnson, Bhat, and Cushing. This paper had a limited amount of data from a 4 MW countercurrent spray tower. The pilot spray tower tested by the authors is a 5-foot diameter counter current flow tower with four spray levels and a proprietary B&W tray design. While the internals are somewhat similar to the Big Bend Unit 1 & 2 FGD, however, the results are not as useful as full scale data (e.g. the OMU testing) because of the uncertainty introduced by when scaling up the results to a full sized absorber.

The reported results are shown in Table 3 below:

Table 3, 4MW Pilot Plant

Inlet	Outlet	Removal Efficiency
lb/MBtu	lb/MBtu	%
0.42	0.041	90
0.22	0.026	88
0.15	0.03	80
0.15	0.014	91
0.13	0.022	83
0.061	0.045	26
0.046	0.044	4
0.046	0.049	(increase of 7%)
0.042	0.037	12
0.037	0.017	54
0.021	0.022	(increase of 5%)
0.012	0.027	(increase of 125%)
0.0073	0.023	(increase of 215%)

This data indicates that at inlet loading above 0.1 lb/MBtu the FGD removes 80% to 91% of the particulate and emits particulate concentration in the range of 0.014 to 0.03 lb/MBtu. These results support an argument that a wet FGD provides significant particulate removal at high inlet particulate loading. However, as inlet particulate loading becomes less, there is a significant drop in particulate collection efficiency. For example, below an inlet loading of 0.021 lb/MBtu, the collection efficiency was essentially zero with an indication that there was a particulate pick-up across the absorber. Removal efficiencies between these data points (below 0.1 lb/MBtu and above0.021 lb/MBtu) ranged somewhat randomly between 5% and 50%.

Summary of Literature Search

In conclusion, there is no publication that provides an analytical method to calculate particulate collection of a wet FGD. Neither is there enough data in the publications to prepare a comprehensive correlation of removal efficiency to other relevant parameters as it relates to the operation of the Big Bend FGD units.

However, the limited search did validate the concept that particulate collection in a wet FGD can be significant depending upon site specific conditions. Collection efficiency is expected to be a function of the specific design of the FGD in question, as well as, the characteristics and quantity of the inlet ash. The data clearly support the notion that collection efficiencies will generally increase as the inlet particulate loading increases. This appears to be especially true when the inlet loading is greater than 0.04 lb/MBtu. Conversely, lower inlet loading results in lower collection efficiencies. The data also demonstrates that at inlet particulate inlet loading of less than 0.04 lb/MBtu, there is insufficient drop in collection efficiency and in some cases, little if any net removal of particulate. The closest FGD absorber in design to the Big Bend unit is the OMU high velocity absorbers. Data from OMU supports a conclusion that little particulate is removed when the inlet particulate loading is less than 0.05 lb/MBtu.

3 DATABASE SEARCH

With the conclusions in mind from the above-described technical papers, a search was performed in order to determine what databases and other information exists on the removal of fly ash particulate from a wet FGD system. A number of databases were explored including ABI Inform, Dialog, and the Energy Citations database. Unfortunately, there were no results found that directly answered our question. This was not unexpected because the question of particulate removal in wet FGDs has not had a high priority in the air pollution control community.

However, the EPA's database did have significant testing on Hazardous Air Pollutants (HAPs) some of which are expected to be in a solid particulate form at the inlet of the FGD system. This database is referred to as the ICR (Information Collection Request) database. This testing and database was created to help identify the amount of HAPs capture by conventional air pollution control technologies on coal fired power plants.

This HAP database consisted of inlet and outlet concentration measurements around control equipment (expressed as either pounds per million BTU or pounds per trillion BTU's) at coal-fired installations around the United States. Some of the sites were named and some were "coded" so it was not possible to determine the specific site. S&L created a subset of the sites by eliminating all sites that did not possess a wet FGD system as its control technology. This data reduction was done in order to select sites as close in design and operation to the TECo's Big Bend Units as possible. However, without specific design information on the FGD, a definitively reliable correlation cannot be developed.

S&L did a further reduction by elimination of all organic HAP's as well as relatively low boiling point metals (less than 4500^0F). This elimination was performed to ensure that the results of the data analysis would be reflective of solid fly ash particles collected in the FGD system and not include any vapor component. These reductions resulted in a total of 9 sites with wet FGD systems and 4 elements [Chromium, Cobalt, Molybdenum, and Vanadium] that were tracked for reduction across the FGD system.

Therefore, we hypothesize that from the inlet and outlet concentrations of these elements it was possible to calculate, for each site and for each selected element at each site, the removal efficiency of these metals (not particulate mater) across the FGD system. We further hypothesize (although very cautiously) that the collection rate of these specific HAPs (in particulate form at the FGD inlet) represents the general collection efficiency of all particulate entering the FGD system. The results are shown in Table 4, below:

Table 4, HAP Data for Wet FGD System

Metals	Data				
	Average	Maximum	Minimum	Standard Deviation	Count
Chromium	58.18%	96.75%	1.37%	34.19%	9
Cobalt	58.59%	98.22%	-10.00%	39.15%	8
Molybdenum	51.17%	98.19%	-3.38%	44.85%	7
Vanadium	67.16%	96.29%	3.92%	35.49%	9
Average Value	58.78%	97.36%	-2.02%	38.42%	

Even though the ICR database does not indicate the inlet particulate loading to the FGD system, in S&L's judgement, the loading is between 0.03 and 0.1 lb/MBtu for these sites. Our reasoning is that most of these sites installed FGD systems to comply with the 1971 NSPS or the 1978 NSPS requirements and these rules required particulate emissions of 0.1lb/MBtu and 0.03 lb/MBtu, respectively.

These results can be used to judge the order-of-magnitude of particulate removal of an FGD system, however, the results can not be applied specifically to Big Bend's FGDs because the specific absorber design was not identified, nor was the actual inlet particulate loading identified for the specific tests. Using the average of all data in Table 1, a predicted removal rate of these specific HAPs and, hypothetically, particulate matter in general, across a FGD system would be approximately 50 to 60%. This prediction correlates well with data from the other sources (i.e. OMU, etc...) if the inlet loading is assumed to be at the high end of the range (0.1 lb/MBtu) and not so well if the inlet loading is assumed to be at the low end of the range (0.03 lb.MBtu).

4 VENDOR KNOWLEDGE AND DATA BASE

The wet FGD vendors have been evaluating their own specific designs for particulate collection as a potential application for fine particulate and HAPs collection. They claim to have developed mathematical correlation that would be helpful in our evaluation of the Big Bend systems. However, they are not willing to provide their valuable proprietary curves. Each supplier's correlation is dependent upon their design and unique inlet loading data, very much like site specific data. Therefore, S&L asked several vendors for their predicted removal efficiency at both 0.06 lb/MBtu and 0.03 lb/MBtu inlet loading. The vendors were given a fly ash distribution that S&L assumed to represent the particle sizes and loading to be leaving TECo's precipitators. S&L also described the TECo Unit 1&2 wet FGD as follows,

- Countercurrent spray tower with four levels of spray
- Dual flow tray
- L/G = 80 gal/acfm
- Saturated gas velocity = 14 fps

The vendor responses are in Table 5 below:

Table 5, Vendor Projections of Removal Efficiency

	Efficiency @ 0.06 lb/MBtu Inlet Loading (%)	Efficiency @ 0.03 lb/MBtu Inlet Loading (%)
Vendor 1	75-85%	70-80%
Vendor 2	75%	50%
Vendor 3	63%	63%
Average Efficiency	73%	63%

Based upon this vendor information, a wet FGD system could remove 73% and 63% of fly ash at a precipitator outlet loading of 0.06 and 0.03 lb/MBtu, respectively. Unfortunately, the vendors noted that these are predicted values only, and that guaranteed values would be on the order of twenty (20) percentage points less.

The vendor data looks overly optimistic as compared to OMU's actual test data available at the 0.06 lb/MBtu level.However, if the 20 percentage points are taken off the average vendor prediction it approaches that seen during field testing at the OMU facility. Specifically, the vendor data would be 53% as compared to OMU's values of 36% and 45%. The vendor predictions at the 0.03lb/Mbtu level despite a 20% reduction remains extremely suspect as compared against actual field data. Without the aid of actual field test data it would be rational to expect much smaller collection efficiencies would occur at low inlet loading. Additionally, there exists a minimum particulate emissions threshold or limit that is inherent to FGD operation, regardless of inlet loading to the FGD. This further reduces the likelihood that such large removal efficiencies could occur at low inlet particulate loads.

5 CONCLUSION

Due to the limited published test data on the FGD system particulate capture, the IRC data base on HAP testing, and related information received from these FGD system suppliers, only limited conclusions can be derived.

- We are not able to find in the literature a correlation for predicting particulate (i.e. fly ash) capture in conventional wet FGD systems treating flue gas from coal fired boilers.
- We would expect that there is a difference in particulate collection between the two independent FGD systems on the Big Bend Units. This is due to differences in absorber design and respective mass transfer devices (multiple loops, trays, L/G, etc...). We were not able to quantify this difference.
- The most reliable data set evaluated was the OMU testing. From this data we expect the Big Bend Unit 1 & 2 FGD system to collect approximately 50 - 60% of the particulate matter entering when the inlet loading is in the range of 0.1 lb/MBtu. Also, we would expect the collection efficiency to drop to approximately 30-40% at an inlet loading of 0.05 lb/MBtu and then the removal efficiency would steeply decline at lower inlet loading. The efficiency is expected to drop to zero at an inlet loading of between 0.02 and 0.03 lb/MBtu.
- The conclusion drawn from the OMU testing are fairly well supported by the pilot data especially in predicting the steep reduction in efficiency as the inlet loading drops below 0.04 lb/MBtu.

- The ICR database on HAPs collection in wet FGD systems supports the OMU based conclusions at high inlet loading but not at low inlet loading. This is most likely due to a poor understanding of the actual inlet loading during the test work.
- The vendor-supplied information also supports the OMU based conclusion at the higher inlet loading. However, there is a disconnect at the low inlet loading with no explanation readily available.
- In reference to the curve developed by TECo in their BACT analysis, S&L concludes that the curve is generally consistent with our expectations for the Big Bend FGD systems. Specifically, the TECo curve predicts approximately five (5) percentage points greater removal at 0.1 lb/MBtu, equivalent reductions at the 0.05 lb/MBtu emission rate, and approximately thirteen (13) percentage points greater removal at the 0.03 lb/MBtu emission rate.